INTERNATIONAL JOURNAL OF CURRENT RESEARCH IN CHEMISTRY AND PHARMACEUTICAL SCIENCES

(p-ISSN: 2348-5213: e-ISSN: 2348-5221)
www.ijcrcps.com

Research Article

ANALYSIS OF NUTRIENT STATUS AND BACTERIAL POPULATION IN BACTERIALLY COMPOSTED PRESSMUD

R. KAVITHA* AND D. KANCHANA

Department of Microbiology, Annamalai University, Annamalai Nagar – 608 002, Tamil Nadu, India.

*Corresponding Author

Abstract

The present study was aimed at investigate the physico–chemical properties of phosphate solubilizing bacteria and sugar mill waste pressmud as composting material. Three bacterial species *viz*., *Bacillus subtilis, Bacillus megaterium* and *Enterobacter asburiae* was tested *in vivo* condition. The results of the present research revealed that the triple inoculation showed higher nitrogen content recorded in Compost Mixture – 8 (CM – 8) (2.68%). The maximum phosphorus content was also recorded in CM – 8 (2.47%). Maximum potassium content was recorded in CM – 8 (3.40%).

Keywords: Phosphate solubilizing bacteria, Pressmud, Nitrogen, Phosphorus and Potassium.

Introduction

For year's sugar industries faced a major challenge in proper utilization of the wastes generated in the process of sugar manufacturing in their plant. Therefore, there is considerable economic interest in the technology and development processes for effective utilization of these wastes (Zhang *et al.,* 2000; Saranraj and Stella, 2012). As a result emphasis is now on aerobic composting, that converts wastes into organic manure rich in plant nutrients and humus and biodegradation of lignocellulosic wastes through an integrated system of composting with bio-inoculants (Singh and Sharma, 2002; Saranraj and Stella, 2014).

Pressmud contains fairly high quantities of plant nutrients that are essential for plants besides being a very effective as soil amendment. Pressmud contains appreciable of nitrogen, Ca, Mg, S, trace element and organic matter. It also contains about 1% sugar, crude fiber and coagulated protein including cane wax, albuminoids, inorganic salts and particles (Mayalagu *et al.,* 1983). Though press mud is very useful, now it is a serious problem because the lack of proper management. The improper management of this waste causes human and animal diseases, pollutes the air and soil environment and destroys natural ecosystem balance. Studies show that on an average, Bangladesh is producing about 0.85 million tons of sulphitation press mud every year from sulphitation process (Bokhtiar and Sakurai, 2005). Unfortunately, extensive research still needs to be undertaken for developing protocol for rapid degradation of press mud into enrichment compost (Saranraj and Stella, 2012; Saranraj and Stella, 2014).

Among the microbes, bacteria are the most important one for decomposing waste. Bacteria use press mud for their metabolism and finally they produce some simple and useful compounds from them which are important for soil health, plant growth and over all to keep well balance of natural ecosystem (Zaved *et al.,* 2008).

Materials and Methods

Microbial source

Three strain phosphate solubilizing bacteria Bacillus *subtilis, Bacillus megaterium and Enterobacter asburiae* were tested for *in-vitro* bioconversion/composting of

press mud. These bacteria were identified in Microbiology Laboratory.

Collection of pressmud

The Sugar mill waste (Pressmud) to be composted was collected from MRK Co-operative Sugar mill, Sethiathope, Cuddalore District, Tamil Nadu, and India. The collected Pressmud samples were stored in polythene bags and were analyzed for its physical, chemical and biological properties.

Physico – chemical analysis of Compost mixtures

Parameter	Method	Reference
Total nitrogen	Using Sani automatic kjedahl apparatus.	Bremner (1965)
Total phosphorus	Vanadomolybdic colorimetric method	Jackson (1973)
Total potassium	Neutralization of triacid with ammonia method and reading in an ELICO CL-360 flame photometer	Jackson (1973)

Treatment schedule

CM-1 - Pressmud alone
CM-2 - Pressmud + *Bacillus subtilis*
CM-3 - Pressmud + *Bacillus megaterium*
CM-4 - Pressmud + *Enterobacter asburiae*
CM-5 - Pressmud + *Bacillus subtilis* + *Bacillus megaterium*
CM-6 - Pressmud + *Bacillus megaterium* + *Enterobacter asburiae*
CM-7 - Pressmud + *Bacillus subtilis* + *Enterobacter asburiae*
CM-8 - Pressmud + *Bacillus subtilis* + *Bacillus megaterium* + *Enterobacter asburiae*

Results and Discussion

Changes in the nitrogen content during composting of pressmud were investigated in the present research. From the results, it was explained that the nitrogen content increased composting periods in the all treatments explained Table - 1. Maximum nitrogen content was recorded in CM – 8 (Pressmud+ *Bacillus subtilis*+ *Bacillus megaterium* + *Enterobacter asburiae)* (2.68%) at 90th day followed by CM – 5 (2.64%), CM – 6 (2.59%), CM – 5 (2.50%), CM -3 (2.28%), CM – 2 (2.09%) and CM - 4 (2.03%). Least amount of nitrogen content recorded in CM – 1 (Pressmud alone) (1.92%). The increase in nitrogen content during composting might be a direct manifestation of mass loss and carbon loss (Nagarajan, 1985; Rasal *et al.,* 1990; Singh *et al.,* 1992; Maleena, 1998; Saranraj *et al*., 2010; Saranraj and Stella, 2012; Saranraj and Stella, 2014).

Phosphorous content was changed during composting of pressmud presented in Table - 2. The phosphorous content was gradually increased during 90th day of composting in all the treatments. During 90th day, phosphorous content triple inoculants CM - 8 (Pressmud + *Bacillus subtilis* + *Bacillus megaterium* + *Enterobacter asburiae)* (2.47%) followed by CM - 5 (2.42 %), CM – 6 (2.40 %), CM – 7 (2.37 %), CM – 3 (2.32 %), CM – 2 (2.21 %) and CM – 4 (2.16 %). Minimum amount of phosphorous content was showed in CM – 1 (Pressmud alone) (1.89 %). This is probably because of quick microbial activity leading to decrease in volume of the material. Similar results were found by Nagarajan (1985), Anandavalli *et al.* (1998) and Imam and Sharanappa (2002).

In general, potassium content during composting of pressmud is presented in Table – 3. From the result, it was determined that the potassium content gradually increased during composting period in all treatments. Change in maximum potassium content was recorded in CM – 8 (Pressmud + *Bacillus subtilis* + *Bacillus megaterium* + *Enterobacter asburiae*) (3.40%) at 90th day followed by CM – 5 (3.21%), CM – 6 (3.18%), CM – 7 (3.17%), CM – 3 (3.00%), CM – 2 (2.97%) and CM – 4 (2.91%). The minimum potassium content was recorded in CM – 1 (2.79%). Manickam (2005) reported that the composted pressmud contains 2.5, 3.0 and 3.5 per cent nitrogen, phosphorus and potassium.

The bacteria present in the compost mixtures (Compost mixture – 1 to Compost mixture – 8) were estimated quantitatively during the 90th day and the results were showed in Table – 4. In all the treatments the bacterial population was more in CM – 8 (29.32 × 10^6 cfu g^{-1}) and less in CM-1 (15.00 × 10^6 cfu g^{-1}). In press mud population of bacteria decreased due to the thermophillic stage of the composting process which eliminated the mesophillic population over larger period of decomposition as a result of cooling effect (Bertoldi *et al.,* 1988; Rajani, 2004).

Table – 1: Increase in total nitrogen content during composting of pressmud

S. No	Treatments	Total nitrogen content (%)			
		Day- 0	Day - 30	Day - 60	Day – 90
1	CM-1 - Pressmud alone	1.20 (6.52)	1.38 (6.73)	1.59 (7.22)	1.92 (8.09)
2	CM-2 - Pressmud + *Bacillus subtilis*	1.25 (6.53)	1.41 (7.01)	1.78 (7.67)	2.09 (8.47)
3	CM-3 - Pressmud + *Bacillus megaterium*	1.26 (6.38)	1.69 (7.41)	2.05 (8.31)	2.28 (8.71)
4	CM-4 - Pressmud + *Enterobacter asburiae*	1.25 (6.52)	1.44 (7.02)	1.71 (7.42)	2.03 (8.27)
5	CM-5 - Pressmud + *Bacillus subtilis*+ *Bacillus megaterium*	1.29 (6.53)	1.94 (8.12)	2.49 (9.04)	2.64 (9.37)
6	CM-6 - Pressmud + *Bacillus megaterium* + *Enterobacter asburiae*	1.28 (6.52)	1.86 (7.88)	2.44 (9.06)	2.59 (9.24)
7	CM- 7 - Pressmud + *Bacillus subtilis* + *Enterobacter asburiae*	1.28 (6.52)	1.84 (7.88)	2.23 (9.06)	2.50 (9.22)
8	CM-8 - Pressmud + *Bacillus subtilis* + *Bacillus megaterium* + *Enterobacter asburiae*	1.33 (6.80)	2.08 (8.32)	2.61 (9.28)	2.68 (9.42)
SE_D		0.01	0.09	0.13	0.21
CD (P= 0.05)		0.03	0.18	0.26	0.42

Values in parenthesis are arcsine transformed values

Table – 2: Increase in total phosphorus content during composting of pressmud

S. No	Treatments	Total phosphorus content (%)			
		Day- 0	Day - 30	Day - 60	Day – 90
1	CM-1 - Pressmud alone	1.16 (1.27)	1.27 (6.52)	1.38 (6.80)	1.89 (7.90)
2	CM-2 - Pressmud + *Bacillus subtilis*	1.16 (6.27)	1.32 (6.80)	1.81 (7.90)	2.21 (8.72)
3	CM-3 - Pressmud + *Bacillus megaterium*	1.17 (6.24)	1.78 (7.90)	2.12 (8.52)	2.32 (8.91)
4	CM-4 - Pressmud + *Enterobacter asburiae*	1.16 (6.27)	1.27 (6.53)	1.76 (7.71)	2.16 (8.51)
5	CM-5 - Pressmud + *Bacillus subtilis*+ *Bacillus megaterium*	1.19 (6.29)	2.19 (8.51)	2.21 (8.51)	2.42 (9.10)
6	CM-6 - Pressmud + *Bacillus megaterium* + *Enterobacter asburiae*	1.18 (6.27)	1.98 (8.13)	2.18 (8.53)	2.40 (8.87)
7	CM- 7 - Pressmud + *Bacillus subtilis* + *Enterobacter asburiae*	1.18 (6.27)	1.81 (7.91)	2.16 (8.51)	2.37 (8.87)
8	CM-8 - Pressmud + *Bacillus subtilis* + *Bacillus megaterium* + *Enterobacter asburiae*	1.20 (6.29)	2.28 (8.71)	2.39 (9.07)	2.47 (9.10)
SE_D		0.005	0.14	0.11	0.06
CD (P= 0.05)		0.10	0.18	0.24	0.13

Values in parenthesis are arcsine transformed values

Table – 3: Increase in total potassium content during composting of pressmud

S. No	Treatments	Total potassium content (%)			
		Day- 0	Day - 30	Day - 60	Day – 90
1	CM-1 - Pressmud alone	0.97 (6.00)	1.52 (7.37)	2.22 (8.91)	2.79 (9.83)
2	CM-2 - Pressmud + *Bacillus subtilis*	0.97 (6.00)	2.36 (9.07)	2.88 (9.91)	2.97 (10.03)
3	CM-3 - Pressmud + *Bacillus megaterium*	0.99 (6.01)	2.59 (9.13)	2.92 (10.03)	3.00 (10.07)
4	CM-4 - Pressmud + *Enterobacter asburiae*	0.97 (6.00)	2.25 (9.03)	2.48 (9.87)	2.91 (10.01)
5	CM-5 - Pressmud + *Bacillus subtilis*+ *Bacillus megaterium*	1.00 (6.02)	2.89 (9.81)	3.12 (10.31)	3.21 (10.43)
6	CM-6 - Pressmud + *Bacillus megaterium* + *Enterobacter asburiae*	1.00 (6.02)	2.87 (9.81)	3.11 (10.31)	3.18 (10.41)
7	CM- 7 - Pressmud + *Bacillus subtilis* + *Enterobacter asburiae*	0.99 (6.01)	2.86 (9.81)	3.07 (10.27)	3.17 (10.41)
8	CM-8 - Pressmud + *Bacillus subtilis* + *Bacillus megaterium* + *Enterobacter asburiae*	1.08 (6.02)	3.06 (10.31)	3.38 (10.63)	3.40 10.61
SE_D		0.01	0.17	0.13	0.11
CD (P= 0.05)		0.03	0.32	0.26	0.22

Values in parenthesis are arcsine transformed values

Table – 4: Enumeration of total microbial population in compost mixtures during composting of pressmud

S. No	Treatments	Bacteria × 10^6 cfu g^{-1}
1	CM-1 - Pressmud alone	15.00
2	CM-2 - Pressmud + *Bacillus subtilis*	23.22
3	CM-3 - Pressmud + *Bacillus megaterium*	24.41
4	CM-4 - Pressmud + *Enterobacter asburiae*	20.32
5	CM-5 - Pressmud + *Bacillus subtilis*+ *Bacillus megaterium*	26.65
6	CM-6 - Pressmud + *Bacillus megaterium* + *Enterobacter asburiae*	26.08
7	CM- 7 - Pressmud + *Bacillus subtilis* + *Enterobacter asburiae*	24.70
8	CM-8 - Pressmud + *Bacillus subtilis* + *Bacillus megaterium* + *Enterobacter asburiae*	29.32
SE_D		1.60
CD (P= 0.05)		3.20

Values in parenthesis are $\log_{10}$ transformed values

References

Anandavalli, D., P Ramaswami, S.M. Hammeed .1998. Recycling of banana pseudo stem as compost. J Ecotoxicol Environ Monit 8:191-194.

Bertoldi, D.M., F.Zucconi, M. Cirilini .1988. Temperature, pathogen control and product quality. Biocycle 29:43-50.

Bokhtiar, S.M and K. Sakurai. 2005. Effect of application of inorganic and organic fertilizers on growth, yield and quality of sugarcane. Sugar Tech 7:33-37.

Bremer, C. 1965. Inorganic forms of soil nitrogen. Pp 1149 – 1176. In: Black. E.C.A. (Ed.). Methods of soil analysis, Part I, American Society for Agronomy, Madison, Wiscosin.

Imam A. K, Sharanappa .2002. Growth and productivity of maize (*Zea mays* L.) as influenced by poultry waste composts and fertilizer levels. Mysore J Agric Sci 36:203-207.

Jackson, J. 1973. The Remedial options for metal contaminated sites. *Current Opinions in Biotechnology*, 5: 285 - 290.

Maleena I .1998.. Composting piggery waste: A review. Bioresource Technol 63:197-203.

Manickam, T.S. 2005. Substitution of nutrient requirement of crops through ferti – irrigation of distillery spent wash. 37th meet of Sugarcane Research and Development Workers of Tamil Nadu, 26 – 27 August, Rajashree Sugars and Chemicals Ltd., Theni, Tamil Nadu, pp. 47 – 58.

Mayalagu K. 1983. Indian proceedings. National Seminar on Utilization of Organic Waste. Agricultural College Research Institute, Madurai, 110-116 p.

Nagarajan R, T.S. Manicham, G.V. Kothandaraman . 1985. Manuarial value of Coir Pith. Madras Agric J 72:533-535.

Rajani, B.S. 2004. Biodiversity of microorganisms and biochemical characteristics during composting and vermicomposting of urban solid waste, M.Sc. Thesis, University of Agricultural Sciences, Bangalore, 49 p.

Rasal, P. H., P.L. Patil, V.V. Shingte . 1990. A role of *Azotobacter* in enrichment of compost. Proc of VIII Southern Regional Conference on Microbial Inoculants, Pune, 47 p.

Saranraj, P and D. Stella. 2012. Bioremediation of sugar mill effluent by immobilized bacterial consortium. *International Journal of Research in Pure and Applied Microbiology*, 2(4): 43 – 48.

Saranraj, P and D. Stella. 2012. Effect of bacterial isolates on reduction of physico – chemical characteristics in sugar mill effluent. *International Journal of Pharmaceutical and Biological Archives*, 3(5): 1077 – 1084.

Saranraj, P and D. Stella. 2014. Composting of sugar mill wastes: A Review. *World Applied Science Journal*, 31(12): 2029 – 2044.

Saranraj, P and D. Stella. 2014. Impact of sugar mill effluent to the environment: A Review. *World Applied Science Journal*, 30(3): 299 – 316.

Saranraj, P., and D. Stella. 2012. Vermicomposting and its importance in improvement of soil nutrients and agricultural crops. *Novus Natural Science Research*, 1 (1): 14-23.

Saranraj, P., V. Sumathi, D. Reetha and D. Stella. 2010. Fungal decolourization of direct azo dyes and biodegradation of textile dye effluent. *Journal of Ecobiotechnology*, 2 (7): 12 – 16.

Singh, A., S. Sharma. 2002. Composting of a crop residue through treatment with micro-organisms and subsequent vermicomposting. Bioresour Technol 85:107-111.

Singh, S., M. Mishra, S. Goyal. 1992. Preparation of nitrogen and phosphorous enriched compost and its effects on wheat (*Triticum aestivum*). Indian J Agr Sci 62:810-814.

Zaved, H.K., M.M. Rahman, M.M. Rahman. 2008. Isolation and characterization of effective bacteria for solid waste degradation for organic manure. KMITL Sci Tech J 8:44-55.

Zhang, B. G., G.T. Li, T.S. Shen, J.K.Wang. 2000. Changes in microbial biomass C, N and P and enzyme activities in soil incubated with the earthworm *Metaphire guillelemi* or *Eisenia foetida*. Soil Biol Biochem 32:2055-2062.